MSF Collablorators

1. MSF Collaborators

The MSF team is collaborating with several research groups at JPL, developing interfaces to their simulation tools as a way to give autonomy researchers access to high-end simulators via the MSF framework. There is also a team effort going on in developing an environment model with a client-server structure to give researchers access to empirical and synthetic surface environment data. The following is a short description of our collaborators' projects and our collaborating efforts.

2. Rover Analysis, Modeling and Simulation (ROAMS)

The ROAMS rover simulator provides detailed physics-based models for the rover and its subcomponents. The simulation capability is highly configurable to seamlessly support the needs of different simulation scenarios, and has provisions for selecting simulation granularity commensurate with the maturity and requirements of the specific autonomy technologies. Such variable fidelity provides a smooth maturation and migration path from early developmental to detailed closed-loop simulations as a prelude to running on physical hardware.

While ROAMS is being primarily developed, used, and validated by the Mars Technology Program (MTP) for the 2009 Mars Science Laboratory (MSL) mission, extensions and adaptations for use within the MSF are being carried out within this task. While the MTP focus is on the development of high-fidelity simulations and validating them against field data, the focus here is on the architectural design and extensions to make this detailed capability usable and accessible for autonomy technology simulations. ROAMS is being adapted for the MSF to support realistic autonomy simulation scenarios in closed loop with autonomy planning and execution technologies. For instance, models under development include detailed simulations of arm deployment, inertial sensors, resource modeling to support realistic simulation scenarios with variable levels of fidelity, and physics based interactions under nominal and off-nominal conditions.

The K9 rover and various subsystems were integrated into the last two MSF releases. An interface was established to meet the needs of current MSF customers, including high-level vehicle commands, pan/tilt and instrument commands, simulation control commands, and basic Time Management. The MSF/ROAMS component has provisions for vehicle telemetry as well as simulation data features that will be exploited in a future MSF release. Current efforts include changing the MSF-ROAMS interface to make it compliant with the latest CLARAty interface definitions.

3. SimScape

Early development of the MSF made use of existing Digital Elevation Maps (DEMs) for simulated Martian terrain, and subsequent development included datasets from some of JPL's premier terrain generators (Maker and VisSite). It quickly became evident, however, that an environment simulation tool designed to meet the needs of autonomy researchers does not yet exist. To solve that problem, the MSF project has teamed with experts in environment simulation at JPL to create SimScape (Simulation of Surface Characteristics and Attributes for Planetary Environments). SimScape consolidates surface environment modeling needs of researchers in autonomy and other mission technologies and serves as an interface to validated simulation environments. SimScape is being designed and developed to:

- Support multiple simulation application domains (rovers; instruments; Entry, Descent, and Landing (EDL); planning; etc.) with associated types of data and levels of fidelity);
- Support synthesis, enhancement, and use of empirical environment models;
- Provide standard interfaces for using and manipulating environment models;
- Provide scalable and efficient use of moderately-sized environment models locally as well as large models from remote servers;
- Provide a repository of environment models for consistent, comparable simulations;
- Allow domain experts to analyze, modify, and validate environmental models in order to provide validated environment models for mission simulation.

SimScape uses a client-server approach to permit a single interface (the Environment Model Client) to be linked into the applications that need to interact with the environment. It includes a server that allows access to multiple sources of environment information including empirical and synthetic surface environment data. SimScape interfaces with state of the art environment generation tools, including Maker1 and Maker2 [8], which allow consistent, multi-scale terrain to be generated in a scientifically cohesive manner, and VisSite [9], which permits the synthesis of a larger class of surface properties (e.g., textures) for use in simulations. A key feature of SimScape for autonomy research is that varying levels of information about the environment are available. For example, a high-level navigation/science planning algorithm might want to know about craters and rocks only, while a low-level navigation planning algorithm might only want {x,y,z} values or stereo images of the terrain. SimScape also includes a local cache database and archiving feature to allow the easy storage and management of generated, empirical and mission-specific environment model datasets.

Dynamics and Real-Time Simulation

Dr. Abhinandan Jain

Exploration Systems - Autonomy Parallel Applications Technologies
Dr. Daniel S. Katz

In-Situ Site Characterization
Dr. Meemong Lee